Collaborative Technology Alliance (CTA)

Robotics

GENERAL DYNAMICS
Robotic Systems

Charles Shoemaker
ARL Collaborative Alliance Manager

Kevin Bonner
Consortium Manager, General Dynamics Robotic Systems

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Consortium Partners

- GD Robotic Systems (Lead)
- Applied Systems Intelligence
- BAE Systems
- Jet Propulsion Lab
- Micro Analysis & Design
- Sarnoff Corporation
- SRI International
- Carnegie Mellon University
- Florida A&M University
- University of Maryland
- PercepTek
- SSC

Objectives

Make the research investments that support the Army's autonomous mobility goals:

- ***Develop perception technologies that allow robotic vehicles to understand their environment;***
- ***Develop intelligent control technologies enabling robotic systems to autonomously plan, execute, and monitor operational tasks undertaken in complex, tactical environments;***
- ***Develop human-machine interfaces that allow soldiers to effectively***

Technical Areas

- Perception
- Intelligent Control & Behaviors
- Human-Machine Interface

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CM: GDRS, Kevin Bonner
CAM: ARL, Charles Shoemaker

Perceive

Enables robotic vehicles to understand their environment

Control

Enables robotic vehicles to intelligently plan & execute military missions

Supervise

Enables soldiers to seamlessly task robotic assets for missions as part of a mixed combat team

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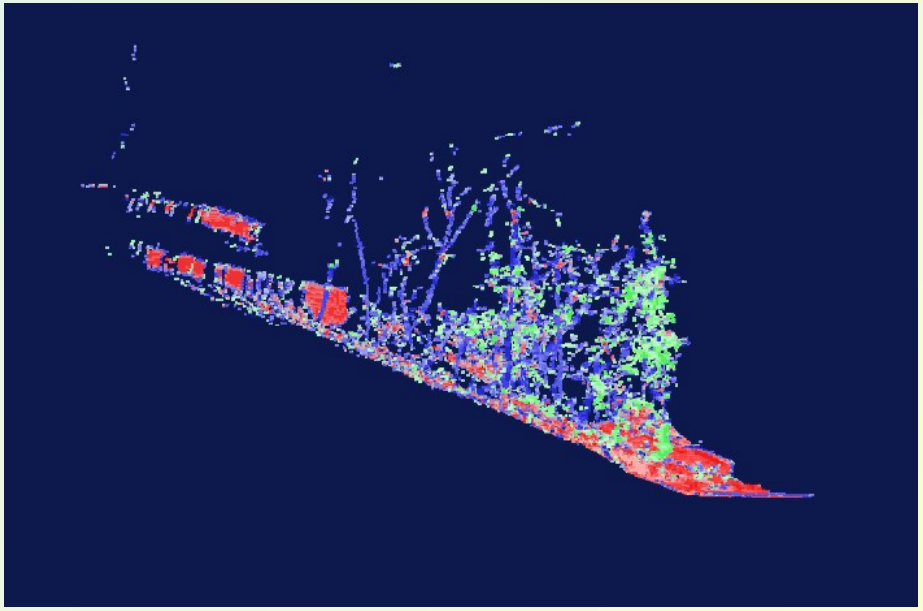
Major Accomplishments

In “Perception”

Advances in:

- LADAR processing refinements leading to finer resolution and better separation of the objects from their backgrounds
- New stereo techniques that are tuned to complex environments such as forests and grassy environments
- Detecting water
- Detecting and identifying thin wires
- Detecting moving objects

Results in faster, stealthier robots



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Major Accomplishments

In Intelligent Control

Advances in:

- Robust local planning
- Maneuver in dynamic environments
- Tactical behaviors
- Collaborative operations

Enables collaborative operation of manned & unmanned air & ground platforms

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Major Accomplishments

In Intelligent Control

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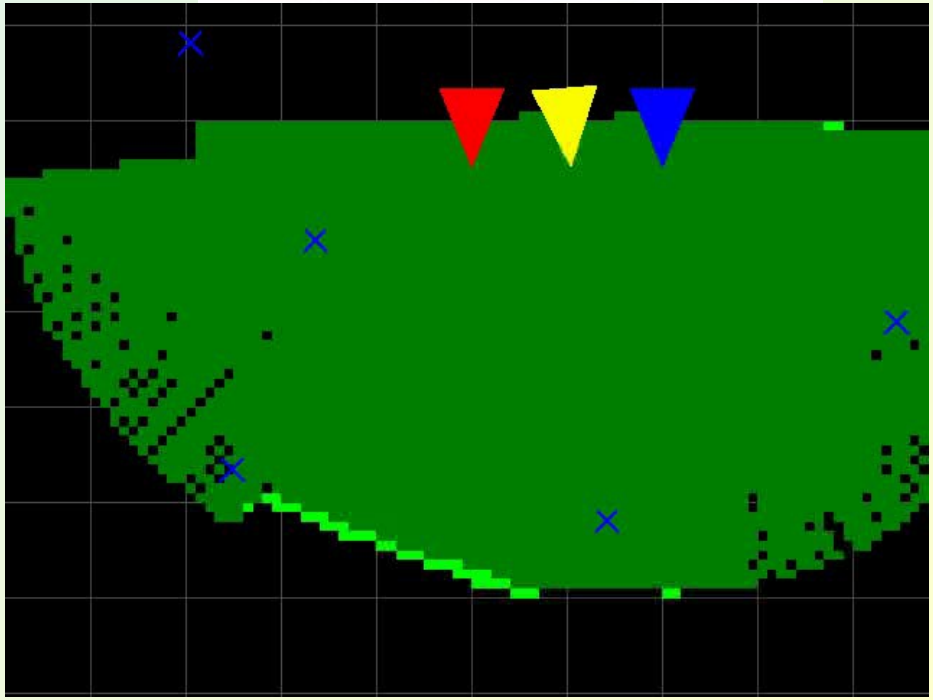

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Major Accomplishments

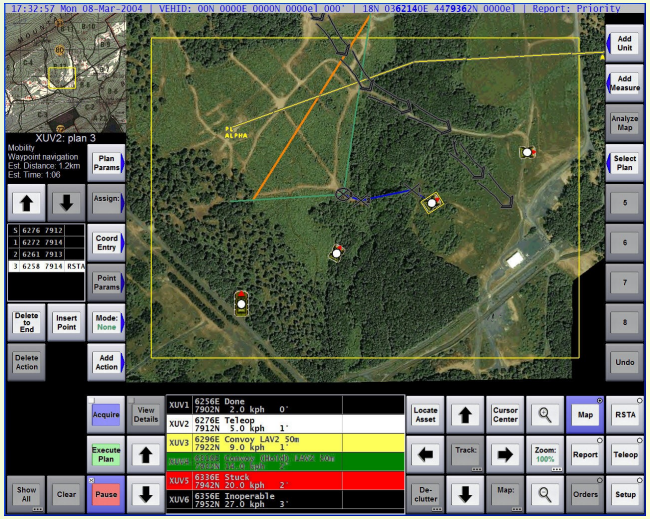
Human-Machine Interfaces

Advances in:

- Scalable Operator Control Unit
- Multi-mode control
- Spoken Language Interface

Reduces the workload of controlling multiple robotic assets

OCU with RSTA view



OCU with Map view

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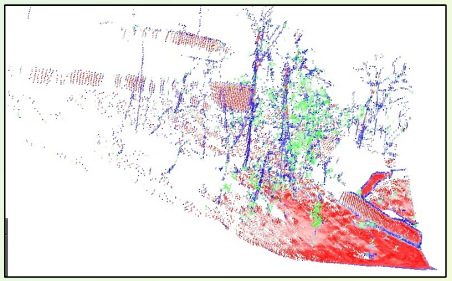
Focused Initiatives

Object Classification & Identification

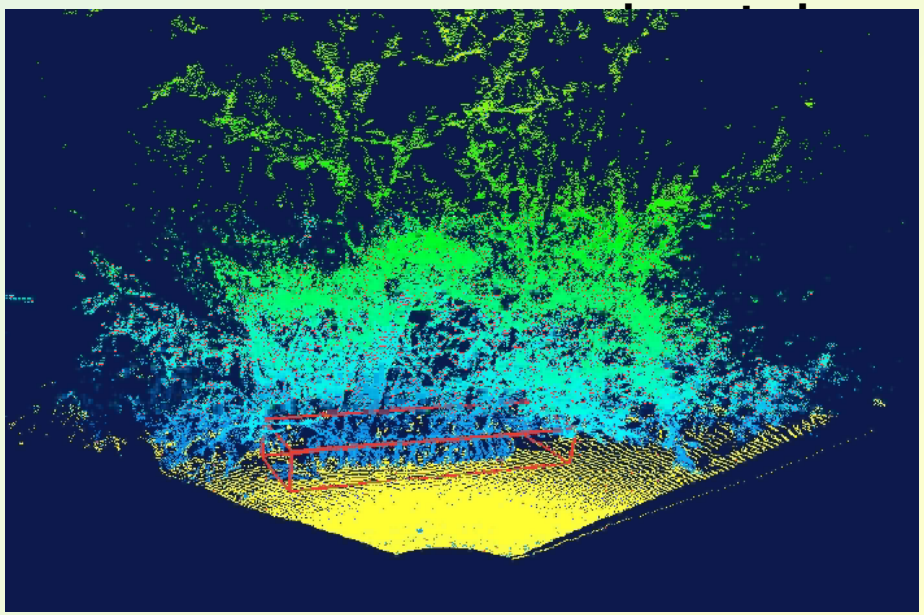
- **Multi-sensor registration & fusion:**
- **Scene segmentation**
- **Ability to detect & classify individual scene components & structures of multiple elements**

This capability will be critical in future UGV systems to fully comprehend the local environment – for mobility & behaviors.

Input scene



Classification output of 3D points (red: surfaces, green: vegetation, blue:



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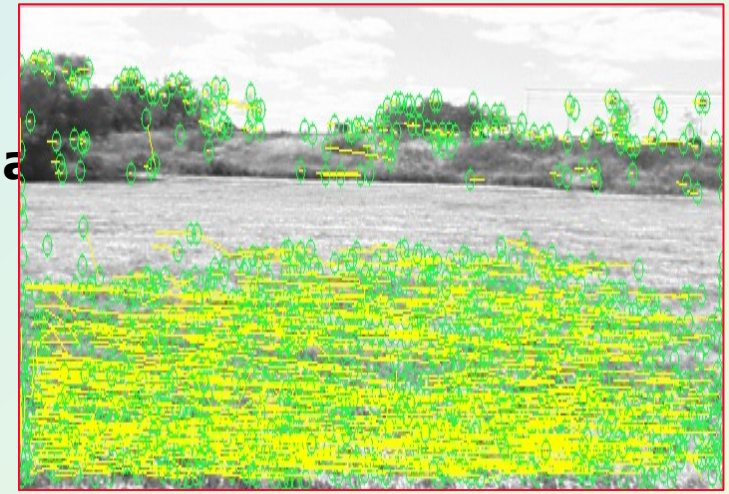
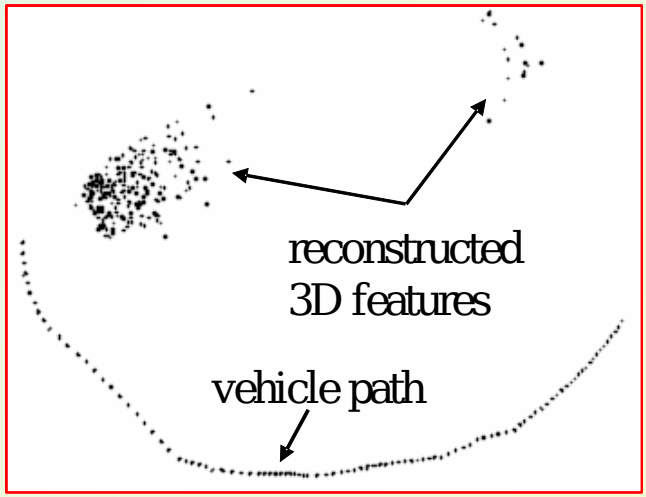
Focused Initiatives

Mid-range Sensing

- **Developed techniques to estimate the range of structures out to a kilometer from robot**
- **Permits “coarse” estimation of the environment for planning.**
- **“Visual odometry” process aids vehicle navigation, especially under**





Using very accurate determination of vehicle position and orientation, locations of objects in the scene can be determined by triangulation applied to video images.

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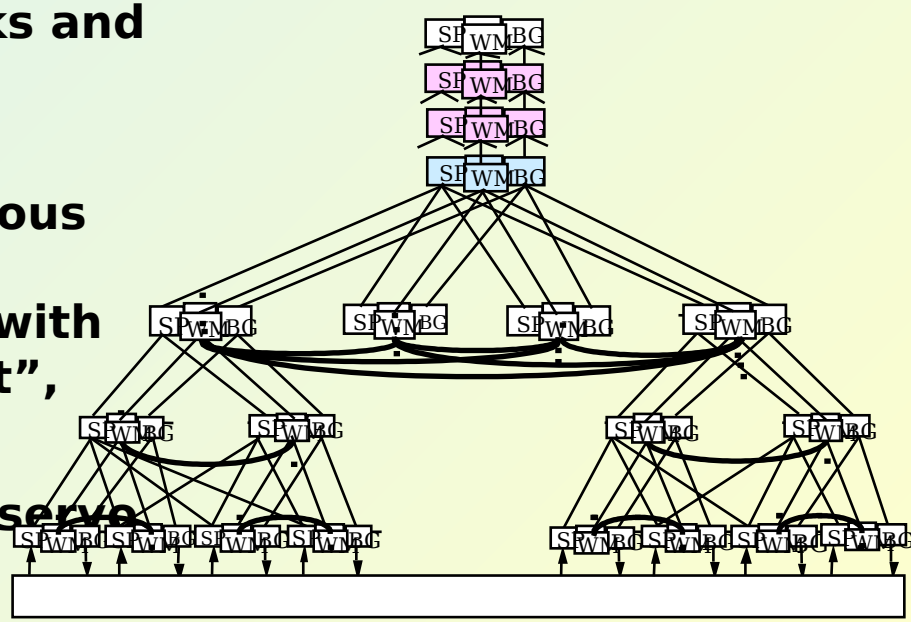
Focused Initiatives

Tactical Behaviors

Implemented the 4D/RCS architectural framework to provide capabilities to:

- **Support deliberate and reactive tactical behaviors to include tactical skills, individual tasks and collective tasks;**
- **Support implementation of autonomous command and control of behaviors associated with execution of "move", "look", "shoot", and "communicate" tasks;**
- **Span multiple levels of control from servo up to platoon including ensemble (unmanned air and ground vehicles and unattended ground sensors) unmanned battle teams;**



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Transitions and Tech Transfers

To TARDEC's Vetronics Technology Integration program

- **All hardware and software**
- **Sensor processing algorithms,**
- **Vehicle planners**
- **RCTA's 4D Real Time Control System (4D-RCS) intelligent system control architecture**

RCTA technology transferred to the 18-ton Stryker

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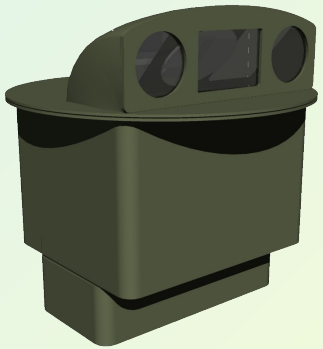
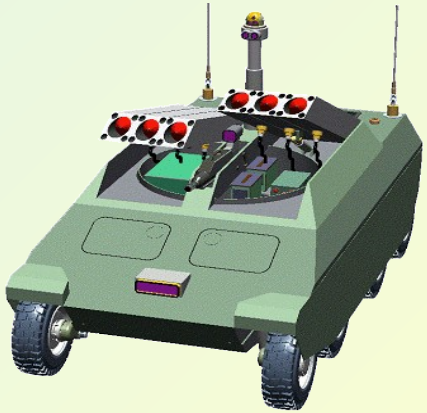
Transitions and Tech Transfers

To Future Combat Systems Autonomous Navigation System program

- **Field tested laser scanner hardware**
- **Laser processing algorithms for obstacle detection and classification**
- **Engineering visualization tools for laser and vehicle planner development**
- **Operating robotic testbed platforms (with interfaces to navigation sensors) fully capable of data collection and archiving in realistic tactical environments**





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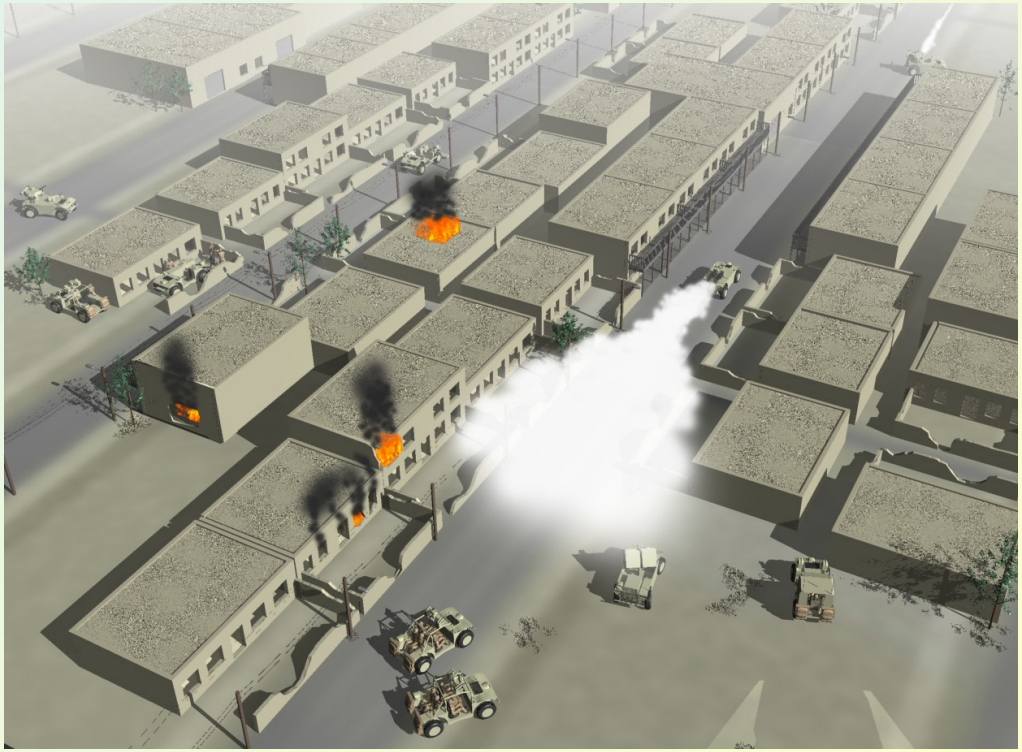
Transitions and Tech Transfers

To Natick Soldier Center's Future Force Warrior program

- **Operational Command Language for specifying mission tasks**
- **Soldier's Decision Support System for command and control of robotic vehicles**
- **Tactical behaviors for robotic platforms performing recon, surveillance and target acquisition (RSTA) missions**
- **Command and Control/Soldier Machine Interface API**
- **Spoken Language Interface for hands-free control of robotic assets**
- **Single-screen OCU for both autonomous and direct Soldier control of robotic assets**



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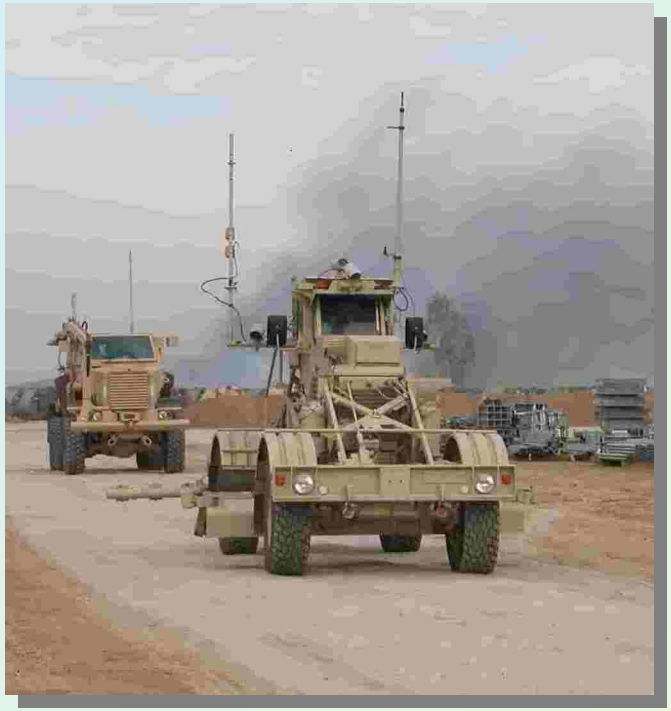
Developing Advanced Capabilities to Meet the Army's Vision

From teleoperation of counter-mine vehicles in Iraq today



To integration of unmanned systems for dismounted operations for the Future Force

To fully autonomous mobility for manned and unmanned vehicles in the Army's Future Combat System